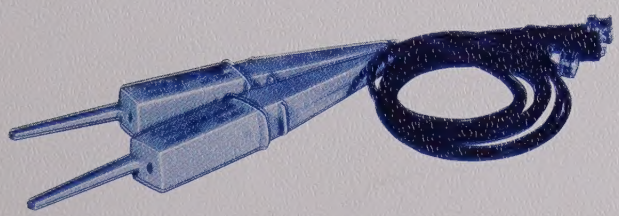
PS163
DUAL TRACE TRIGGERED SWEEP OSCILLOSCOPE



SERVICE MANUAL

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PS163

SERVICE MANUAL

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CIRCUIT DESCRIPTION

SYNC or TRIGGER CIRCUITS

The HORIZONTAL SYNC push button switch selects the source of the sync signal. The output of the HORIZONTAL SYNC switch is AC coupled through C200 to the input protection circuit comprised of CR201 and CR202 and associated components. C203, CR200, and R200 act as a filter to remove high frequency noise that would otherwise result in unstable sync in the DUAL CHOPPED mode. SW200A then connects the sync signal to either the sync separator (TR200-TR203) for the TV Vertical and TV Horizontal sweep positions, or directly to the input of the differential comparitor (TR205-TR212).

The SYNC POLARITY switch (SW2) selects which input of the sync separator or differential comparitor will receive the sync signal, or the reference voltage from the SYNC LEVEL control (R7).

Both the sync separator and the differential comparitor are balanced differential amplifiers, and therefore will accept a signal to either input. The balanced amplifier, in the sync separator section, has just enough gain to reliably operate the sync separator transistor (TR204). The sync separator transistor (TR204) is biased so that only the peaks of the incoming signal will cause it to conduct producing an output signal at its collector load resistor (R222). The output of TR204 goes to both a differentiating network (C211 and R227) and to an intergrating network (C213, C214 and R226). SW200C selects and couples the output of the integrating network for the TV Vertical sweep position or the output of the differentiating comparitor for the T.V. Horizontal sweep.

The HORIZONTAL SWEEP push button (SW3) switch is designed so when in the manual triggered mode, the sync level control is connected to the reference input of the differential comparitor. While in the AUTO TRIGGERED and the FREE RUNNING modes the reference side of the comparitor is connected to ground. The differential comparitor is a very high gain differential amplifier, so even a relatively small input signal will cause TR212 to change from saturation to cutoff, resulting in a 25 volt signal to drive the Schmitt trigger. The Schmitt trigger (TR213 and TR 214) is designed so with no input signal, TR214 is in the on state with the voltage at the emitters of both transistors at approximately plus 10 volts. As soon as the input signal to the base of TR213 exceeds the 10 volt level at its emitter TR213 starts to conduct. When TR213 starts to conduct, two things happen. First, the voltage across the common emitter resistor R254 starts to rise, and second, the voltage at the collector of TR213 starts to drop. TR214 then rapidly changes to its off state as a result of the combination of a positive signal on its emitter, and a negative signal on its base. Thus the output of the Schmitt trigger coupled through C219 to the base of TR 218 is a fast (10mSec) pulse regardless of what the signal to the input of the trigger circuit was.

TIME BASE GENERATOR

The "heart" of the PS163 is the time base generator, and its function is to provide an extremely linear ramp (sawtooth) for use as a horizontal sweep signal. The PS163 accomplishes this by using a constant current source to charge the timing capacitor (C235 - C238). The constant current source is provided by TR227. TR228 is used as a diode for temperature compensation. The base and therefore the emitter voltage for TR227 is determined by the voltage divider R286 - R289. With the emitter voltage of TR227 constant, the output current will remain at a constant value determined by the 1% resistors R290 - R301. SW200F selects the value of timing capacitor, and SW200G selects the value of constant current resistor. R288 is the front panel horizontal frequency vernier and is controlled by the small center knob on the TIME BASE - FREQUENCY switch. R288 must be fully clockwise to maintain time base calibration.

TR218 and TR219 form a Schmitt trigger with TR218 held in the off condition by the negative voltage from the stability control R267. The on condition of TR219 is directly coupled by the emitter follower transistor TR220 producing a negative voltage at the base of TR223 holding it in the on condition. The on condition of TR233 shunts the timing capacitor, therefore producing no sweep signal. When a positive trigger pulse is applied to the base of TR218, it, TR219, TR220, and TR221 instantly change states. The positive voltage coupled to the base of TR223 causes TR223 to stop shunting the output of the constant current source. The output of the constant current source now starts charging the timing capacitor, producing a very linear negative going ramp. The negative ramp is coupled through the high impedance source follower TR229, and amplified by TR230. The negative ramp at the junction of R303 and R304 is coupled back to the base of TR218 through TR226, CR209 and R269, and also charges one of the hold off capacitors selected by SW200E. As soon as the negative ramp at the base of TR218 reaches the lower trip point of the Schmitt trigger, TR218 and TR219 will again change states, with TR219 returning to the on condition. The on condition of TR219 will turn on TR223, returning the voltage on the timing capacitor to zero, and causing the beam to retrace on the CRT. The voltage stored on the hold off capacitors, C231 - C234, keeps the base of TR218 negative long enough for all circuits to reset in preparation for the next trigger pulse.

TR224 and TR225 serve no active purpose in the circuit and are only used to kill all output from the time base when using the VECTOR INPUT, 60Hz or EXT sweep features. The emitter follower TR231 provides an isolated output of the sawtooth for the jack on the rear of the PS163.

The square wave at the emitters of TR220 and TR221 is used to drive the CRT unblanking circuit and the Display board in the alternate sweep mode.

TIME BASE CONTROL CIRCUITS

The control circuit for the time base generator consists of TR215, TR216, and TR217.

In the MANUAL TRIGGERED mode, the base of TR217 is grounded by the HORIZONTAL SWEEP push button switch SW3A. With the base of TR217 grounded, TR217 will be off, and will have no effect on the negative voltage applied to the base of TR218 through the stability control. The stability control has been adjusted so that TR218 will only conduct when it receives a proper trigger pulse from the trigger circuit. There will be no sawtooth sweep produced until the trigger circuit is adjusted to provide a proper trigger pulse.

In the FREE RUNNING mode, the base of TR216 is grounded by SW3C. The base of TR217 is ungrounded because of the mechanical interlock of SW3. Grounding the base of TR216 causes the transistor to turn off, raising the collector voltage to the positive 15 volt level. This positive voltage is coupled through R262, R263 and TR217 to the junction of R265 and R266, which changes the voltage on the stability control enough so that TR218 will conduct as soon as the hold off capacitor has discharged. The time base generator will now free run, but it will be sensitive to trigger pulses coupled into the base of TR218 during the time that it takes for the hold off capacitor to discharge.

In the AUTO TRIGGERED mode, the base of TR216, is grounded through resistor R259, and with no trigger pulses, the action is the same as in the FREE RUNNING mode. If trigger pulses are present, they will be coupled to the base of TR215 through C220. The trigger pulses will be amplified by TR215 and coupled to CR205. CR205 will detect the trigger pulses, producing a positive voltage at the base of TR216, causing it to conduct. Its collector voltage will drop, cutting off TR217, and allowing the stability control to return to the same negative voltage as in the MANUAL TRIGGERED MODE. C222 is used to hold the base of TR217 negative between trigger pulses. In this mode the time base will free run in the absence of trigger pulses. The presence of trigger pulses will cause the time base to automatically switch to a triggered mode.

TR233 and TR234 amplify the horizontal sweep signal, and together with constant current source TR232, establish the push-pull signal necessary to drive the output amplifier. R11 is the front panel horizontal position control. R317 adjusts the gain of TR233 and TR234 to produce a horizontal trace 11cm long. SW5 is a push-pull switch mounted on the rear of the HORIZONTAL POSITION control. When the shaft is pulled to its out position, the switch connects R319 in parallel with R317. R319 is adjusted for 5X increase in the gain of TR233 and TR234. R321 and R322 are ganged together, and are used to match the horizontal position of the expanded sweep to that of the normal sweep.

TR235 and TR236 are used in the EXT horizontal and 60Hz sweep positions to amplify the incoming signal. The output of TR235 is coupled through SW200H to the base of TR233. R331 is the front panel horizontal gain control (small center knob on TIME BASE - FREQUENCY), and R8 (front panel LINE SWEEP PHASE) is used to adjust the phase of the 60Hz sweep.

PREAMPLIFIERS

Both of these amplifiers are identical, so we will look only at the operation of the CHANNEL A preamplifier. The signal at the front panel input is coupled to the input of the preamp through the INPUT COUPLING switch. When this switch is in the DC coupled position, the input signal is direct coupled to the input of the pre amp through R4, the 47 ohm resistor. In the AC position, the signal is AC coupled to the input of the preamp through C2 and R4. In the ground position, the input signal is grounded through R3 (10K) and C2, while the input of the preamp is tied to ground through R4.

Once inside the preamp, the input signal must be attenuated to a level that will not over drive the FET inputs. The attenuation ratios are: 1:1, 10:1, 100:1 and 1,000:1, and are selected by SW100A and SW 100B. In order to maintain exact attenuation at higher frequencies, the 1,000:1 attenuator section is actually a 10:1 and a 100:1 connected in series. The capacitors in the attenuator are used for frequency compensation. The input FET TR100 is connected as a source follower to match the 1 meg input impedance to the low impedance transistor circuitry, and is protected by CR100 and CR101 which clamp the input to plus and minus 2 volts. TR101 along with the DC BALANCE control R120 provide a DC reference for the balanced differential amplifiers that follow. TR103A and TR103B along with constant current

source TR104 produce the necessary push-pull signal for deflection.

TR103A in cascode with TR105 is actually the first stage of voltage amplification. SW100C selects different values of emitter resistors for TR103 to change the gain of this stage in the 1,2,5 sequence necessary to produce the full range of input sensitivities of the preamp. TR108 operates as a current amplifier to drive the low impedance input of the output amplifier and in addition it changes the DC level of the signal. R156 is the front panel vertical gain vernier, and is controlled by the small center knob of the PPV PER DIV. switch. R156 must be fully clockwise to maintain calibration of the preamplifier. R5 and R6 are a dual control used as the front panel TRACE POSITION control.

VERTICAL INPUT
(Switch and Display Board)

The actual switching of either CHANNEL A or CHANNEL B to the vertical output amplifier is accomplished by diodes CR403 - CR410. If a positive voltage is applied to the junction of CR404 and CR 405, they will be reverse biased, and therefore have no effect on the signal from CHANNEL A. CR403 and CR406 will then be forward biased by the difference in DC voltage level between the preamp and the output amplifier, and the signal from CHANNEL A will be coupled to the vertical output amp. If a negative voltage is applied to the junction of CR404 and CR 405, they will be forward biased, and the signal from CHANNEL A will be shunted to ground through TR403. CR403 and CR406 would then be reverse biased by the negative voltage on their anodes, blocking the CHANNEL A signal from reaching the output amplifier. Multivibrator TR404 and TR405, along with emitter followers TR403 and TR406 are constructed so that if a negative voltage is applied to the junction of CR404 and CR405 from the emitter of TR403, then a positive voltage will be applied to the junction of CR408 and CR409 from the emitter of TR406. With a positive voltage at the junction of CR 408 and CR409, they will be reversed biased, while CR407 and CR410 will be forward biased, connecting the output of the CHANNEL B preamp to the vertical output amp.

Pushing the CHANNEL A VERTICAL INPUT button shorts the base and emitter of TR404 resulting in a positive voltage at its collector. This positive voltage is coupled through emitter follower TR403 to the junction of CR404 and CR405, connecting the CHANNEL A preamp to the vertical output amp.

Pushing the CHANNEL B VERTICAL INPUT button shorts the base and emitter of TR405 resulting in a positive voltage at its collector. This positive voltage is coupled through emitter follower TR406 to the junction of CR408 and CR409, connecting the output of the CHANNEL B preamp to the vertical output amplifier.

Pushing the DUAL ALTERNATE VERTICAL INPUT button connects the blanking waveform from the junction of the emitters of TR220 and TR221 on the time base board to the base of TR407. During the retrace time of the sweep, a negative pulse will be coupled to the base of TR407 turning it on. When TR407 turns on, it will shunt the minus 25 volt supply for the multivibrator to ground. With the emitters of TR405 and TR404 shorted together, by the normally closed contacts of the DUAL CHOPPED VERTICAL INPUT switch, the multivibrator is wired as a bistable that will switch states every time the minus 25 volts is removed. Therefore every time the sawtooth from the time base retraces, the multivibrator will change states producing an alternate connection of the CHANNEL A and CHANNEL B preamps to the vertical output amplifiers.

Pushing the DUAL CHOPPED VERTICAL INPUT button removes the short between the emitters of TR 403 and TR404, and applies power to the multivibrator at the junction of R419 and R420. The multivibrator will now free run at approximately 100KHz, with the result that CHANNEL A and CHANNEL B preamps will be switched to the vertical output amplifier during alternate half cycles of the 100KHz chopping frequency. Plus 15 volts is connected by the remaining pair of contacts to R200 on the time base board, activating the low pass filter at the input of the trigger circuit.

Pushing the VECTOR VERTICAL INPUT button does the following: switches the output of the time base board from the horizontal output amplifier to ground, connects the CHANNEL B preamp to the horizontal output amplifier, applies minus 25 volts to R284 on the timebase board stopping the operation of the timebase generator, and shorts base to emitter of TR 404 connecting the CHANNEL A preamp to the vertical amplifier.

The display board also contains the circuit for the 2 volt square wave calibrator. TR400 and TR401 form a free running multivibrator operating at approximately 1KHz. TR402 is a squaring amplifier to improve the rise time of the square wave. R409 is an internal control to set the level of the 2 volt output.

OUTPUT AMPLIFIERS
(Horizontal and Vertical)

The horizontal and vertical output amplifiers are identical in the way that they process the incoming signal. The only difference is that the horizontal amp

has 25% more gain to compensate for the lower sensitivity of the horizontal deflection plates in the CRT.

TR500 and TR501 provide a low impedance termination for the input of the output amplifier, and are actually in cascode with the last stage of the preamp or time base. R504 and R505 are the collector load resistors for this cascode stage. R500 is found only on the vertical output amplifier, and is used to reduce the gain of the cascode stage, to partially compensate for the higher sensitivity of the vertical deflection plates. TR502 and TR503 are emitter followers to provide a low impedance drive for the output stage. TR504 in cascode with TR506 along with TR505 in cascode with TR507 form the output voltage amplifier stage. TR508 and TR509 form a constant current source to prevent the output stage from saturating, even if overdriven. R501 is found only in the horizontal output amplifier, and is used to increase the gain to partially compensate for the lower sensitivity of the horizontal deflection plates. Access to the vertical deflection plates is available through VERT. DEF. PLATES jacks with R11 and R12 used to isolate the vertical output amplifier from the external signal.

SW5 is the VERT DEF PLATES switch and connects the external signal to the deflection plates in the EXT position, and the vertical output amplifier to the plates in the NORMAL position. This switch should be in the NORMAL position for normal operation.

HV POWER SUPPLY and DC Coupled CRT Unblanking Circuit

The PS163 incorporates a 2000 volt high voltage power supply with advanced design, normally found only in much higher priced equipment. Instead of a 60 Hz supply with all the inherent problems of high voltage breakdown and large physical size, the PS163 uses a Hartley oscillator supply operating at 30KHz. The small physical size of the 30KHz transformer and capacitors results in a considerable savings in weight, along with an increase in reliability. TR602 and the primary of the high voltage transformer T600 are the active components of the oscillator. C604 is used to resonate the primary of the transformer to 30KHz. Feedback to sustain oscillation is provided by the small section of the primary winding below the center tap. R609, the 3K resistor, is only used to start the oscillation.

The high voltage transformer is equipped with two secondary windings, one to supply voltage to the cathode of the CRT, and one to provide voltage to the control grid of the CRT. The two windings are isolated from each other and from ground, so that the direct coupled CRT unblanking signal may be applied to the low side of the control grid secondary. The unblanking signal is coupled from the junction of the emitters of TR220 and TR221 on the time base board to the emitter of TR600. This signal is positive when the time base is producing a sweep, and negative when the time base is in the hold off condition.

As soon as the time base starts to sweep, and a positive voltage is coupled to the emitter of TR600, TR 600 will go to the off state. With TR600 off, its collector voltage will go to plus 75 volts, turning on TR601, and placing plus 75 volts on the emitter of TR601. The positive 75 volts change at the emitter of the TR601 will be coupled by R604 - R608 and R608 and C602 to the control grid of the CRT, causing the CRT to conduct producing a trace on the screen. R604 is adjusted to provide just enough negative voltage to the grid of the CRT so the CRT will be turned off in the absence of the unblanking voltage at the emitter of TR600.

With a negative signal applied to the emitter of TR 600, it will be in the on condition, resulting in zero voltage at the collector. This voltage will also be present at the base of TR601, causing TR601 to be in the off condition. With TR601 in the off condition, its emitter voltage will be near zero determined by the forward bias condition of CR603. This voltage is coupled to the CRT grid holding it in cutoff.

The cathode voltage on the CRT is adjusted by the intensity control R13 to provide manual control of the trace brightness. The focus control, R15, is in the same voltage divider as the intensity control so as the intensity control is varied, the focus voltage will follow it. The result is the CRT beam remains focused at any intensity setting.

Provision for Z axis modulation is provided by C6 coupling into the cathode of the CRT. With this input, a positive signal will decrease the brightness of the trace, and a negative signal will increase the brightness of the trace. SW8, the Z AXIS input switch, is used to connect the Z AXIS jack to the cathode when this input is desired. This switch should be in the off position for normal scope operation.

LOW VOLTAGE POWER SUPPLY

The PS163 low voltage power supply incorporates a ferroresonant power transformer (T1), and full wave rectification, to provide regulated voltage outputs of plus 200 volts, plus 75 volts, plus 25 volts, plus 15 volts and minus 25 volts. The blue/white, blue/white winding of T1 is resonated by capacitor C7 to the 60Hz power line frequency. Because of the energy stored in this parallel resonant circuit, the output voltage of T1

will remain constant over a wide range of input voltage variations, and load current variations.

TR700 - TR702 are electronic ripple filters with a filtering action equal to the beta of the transistor times the capacitor from base to ground. These transistors are not protected against a shorted output, so care should be taken when working inside the PS163 not to short the plus 25, plus 15 or minus 25 volt supplies to ground. If these transistors are defective they may not affect the output voltage from the supplies, but will cause an increase in the ripple on the supply lines.

R19, the ASTIGMATISM control on the back panel, is used in conjunction with the FOCUS control to adjust the sharpness of the trace.

DISASSEMBLY INSTRUCTIONS

CASE

The case of the PS163 is in two parts. The first section is the top and side wrap. Remove the 4 philips head screws from the top of the case, and the 5 philips head screws from each side of the case. Slide the wrap about ¼ inch forward, and lift it up and off. The next section is the bottom and rear cover. Remove the three philips head screws holding the cord wrapper on the back of the PS163. Place the PS163 face down on a soft cloth and remove the two philips screws from the aluminum trim bar along the front edge of the bottom. Remove the remaining philips head screws from the bottom of the case, and lift the case straight up being careful not to damage the circuit breaker or astigmatism control. Reverse this procedure for reassembly.

CRT

Place the PS163 face down on a soft cloth and remove the philips screw that secures the rear support bracket for the CRT from the under side of the chassis. Return the PS163 to its normal up-right position. Remove the four philips screws that secure the bottom edge of the output amplifiers from the rear of the chassis. Remove the two screws that hold the output amplifier support bracket from the top of the chassis. Remove the socket from the rear of the CRT. Remove the 4 bezel nuts, the bezel, the green filter, and the grid graticule from the front of the PS163. Remove the 4 black plastic light shields, and note that there are two different types of shields. The shields in the upper right and lower left have the opening in front of the collar, and are used to illuminate the grid graticule. Remove the vector graticule, and note the 4 philips screws that are recessed behind it. Carefully remove these 4 screws while holding the CRT. After the 4 screws are removed, push the CRT to the rear, and swing it out toward the open side of the chassis. Be sure that the front support brackets clear the wiring for the grid lights.

Reverse this procedure to reinstall the CRT. Refer to adjustment procedure for CRT tilt.

CALIBRATION

PREAMPLIFIERS CHANNEL A and B

DC BALANCE

NOTE: It is not necessary to remove the PS163 from its case to adjust DC BALANCE. A misadjustment of the DC BALANCE will result in a position shift of the trace as the preamplifier PPV PER DIV. switch is switched in the 1, 2, 5 sequence.

1. Depress the AUTO TRIGGERED HORIZONTAL SWEEP push button, set the TIME BASE - FREQUENCY switch to the 1mSec./DIV position, and set the preamp INPUT COUPLING switch to the center ground position.

2. Set the preamp PPV PER DIV. switch to the .5 position, and adjust the TRACE POSITION control to center the trace on the major horizontal grid line.

3. Turn the preamp PPV PER DIV. switch to the .05 position, and adjust the DC BALANCE control to re-center the trace.

4. Repeat steps 2 and 3 until there is no shift in the trace position.

CALIBRATION

The preamplifier calibration adjustments (R131, R 134, R137, and R140) are horizontally mounted P.C. pots located on the top side of the preamplifier P. C. boards. Access to these controls for adjustment is

through holes punched through the P.C.board. All that is necessary to calibrate the PS163 preamplifiers is an accurate DC voltage source as shown below:

1. Depress the AUTO TRIGGERED HORIZONTAL SWEEP pushbutton switch, set the TIME BASE - FREQUENCY switch to the 1mSec./DIV position, turn the center knob of the PPV PER DIV switch on the preamplifier fully clockwise, and set the INPUT COUPLING switch to the center ground position.

2. Connect the PS163 through the low cap probe to the voltage source, adjust the voltage source for 1 volt, adjust the TRACE POSITION control to center the trace on the major horizontal grid line, and set the PPV PER DIV switch to the .5 position.

3. Push the INPUT COUPLING switch to the DC position, and adjust R131 for a trace deflection of 2 divisions.

4. Return the INPUT COUPLING switch to the center ground position, set the PPV PER DIV switch to the .2 position, and readjust the TRACE POSITION control if necessary to center the trace on the major horizontal grid line.

5. Push the INPUT COUPLING switch to the DC position and adjust R134 for a trace deflection of 5 divisions.

6. Return the INPUT COUPLING switch to the center ground position, adjust the voltage source for .2 volts, set the PPV PER DIV switch to the .1 position, and recenter the trace if necessary.

7. Push the INPUT COUPLING switch to the DC position and adjust R137 for a trace deflection of 2 divisions.

8. Return the INPUT COUPLING switch to the center ground position, set the PPV PER DIV switch to the .05 position, and recenter the trace if necessary.

9. Push the INPUT COUPLING switch to the DC position, and adjust R140 for a trace deflection of 4 divisions.

ATTENUATOR FREQUENCY COMPENSATION

The first step in compensating the input attenuators on the PS163 is to match the input capacity of the CHANNEL A and CHANNEL B preamplifiers. Proceed with the set up as follows:

HORIZONTAL SYNC:	Int. A
HORIZONTAL SWEEP:	AUTO TRIGGER
TIME BASE - FREQUENCY	.5mSec./DIV
VERTICAL INPUT:	A
CHANNEL A PPV PER DIV	.5 VOLTS/DIV

1. Use one of the 39G34 low cap probes to connect the output of the 2V PP calibrator to the input of CHANNEL A. Adjust the probe compensation capacitor C1 for a square wave with a flat top.

2. Use the same 39G34 probe to connect the 2V PP calibrate signal to the CHANNEL B preamplifier, press the B VERTICAL INPUT button, and the INT B HORIZONTAL SYNC button. Adjust C113 in channel B preamplifier for a square wave with a flat top.

10:1 ATTENUATOR COMPENSATION

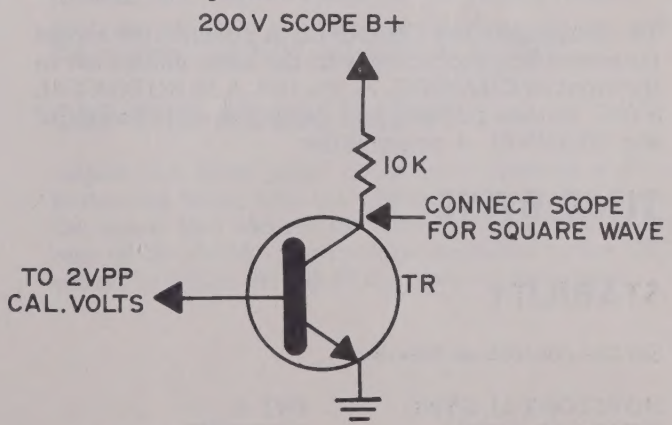
1. With the 2V PP calibrate signal still applied to the CHANNEL B input, turn the CHANNEL B PPV PER DIV switch to the 1 volt position.

2. Adjust C100 for a square corner on the leading edge of the square wave.

3. Adjust C102 to remove any tilt on the top of the square wave.

4. Repeat steps 2 and 3 as necessary to obtain best response to the calibrate signal.

In order to adjust the 100:1 and 1,000:1 attenuators you will need at least a 200V PP square wave. If you do not have such a signal available, the circuit shown below should provide a square wave good enough for attenuator compensation.



Circuit for 200V PP calibration square wave.

TR is a NPN Silicon with a VCE of at least 200 volts, and a power disipation of 3 to 5 watts. This type is used as the video output transistor in some TV receivers.

100:1 ATTENUATOR COMPENSATION

1. Use the 39G34 probe to connect a 200V PP square wave to the input of CHANNEL B preamplifier, and set the CHANNEL B PPV PER DIV switch to the 50 volt position.

2. Adjust C105 for a square corner on the leading edge of the square wave.

3. Adjust C104 to remove any tilt on the top of the square wave.

4. Repeat steps 2 and 3 as necessary.

1000:1 ATTENUATOR COMPENSATION

1. With the 200V PP square wave still applied to the CHANNEL B preamp, turn the CHANNEL B PPV PER DIV switch to the 100 volt position.

2. Adjust C108 for a square corner on the leading edge of the square wave.

3. Adjust C107 to remove any tilt on the corner of the square wave.

4. Adjust C110 to remove any tilt on the top of the square wave.

5. Repeat steps 2, 3 and 4 as necessary.

To compensate the CHANNEL A preamplifier repeat the preceeding procedure with the signal connected to the input of CHANNEL A, the INT A HORIZONTAL SYNC button pushed, and using the adjustments of the CHANNEL A preamplifier.

TIME BASE

STABILITY

Set the controls as follows:

HORIZONTAL SYNC	INT A
SYNC POLARITY	POSITIVE
HORIZONTAL SWEEP	MANUAL TRIGGERED
TIME BASE - FREQUENCY	.5mSEC/DIV
VERTICAL INPUT	A
CHANNEL A INPUT COUPLING SWITCH	CENTER GROUND

1. Adjust R267 the stability control until the trace just disappears.

2. Press the AUTO TRIGGERED HORIZONTAL SWEEP, and check that the trace blinks on.

DIFFERENTIAL COMPARITOR BALANCE

Set controls as follows:

HORIZONTAL SYNC	INT A
SYNC POLARITY	POSITIVE
HORIZONTAL SWEEP	AUTO TRIGGERED
TIME BASE - FREQUENCY	.5mSec/DIV
VERTICAL INPUT	A
CHANNEL A INPUT COUPLING SWITCH	CENTER GROUND

1. Connect the output of the 2V PP calibrator to the input of CHANNEL A using the 39G34 low cap probe.

2. Adjust R233 for a locked in wave form.

3. Turn the TIME BASE - FREQUENCY switch to the 50uSec/DIV position, and check to see that the square wave stays locked in.

4. If the square wave does not stay locked in, retouch the stability control R267 until it does.

SWEEP SPEED and SWEEP WIDTH

Set controls as follows:

HORIZONTAL SYNC	INT A
SYNC POLARITY	POSITIVE
HORIZONTAL SWEEP	AUTO TRIGGERED
TIME BASE - FREQUENCY	2mSec/DIV
VERTICAL INPUT	A
CHANNEL A PPV PER DIV	5/DIV

1. Connect the CHANNEL A input to the yellow/green wire on the terminal strip mounted on the rear apron of the chassis.

2. Adjust R317 for a trace 11 cm long.

3. Turn the CHANNEL A PPV PER DIV switch to .5V/DIV. and adjust the HORIZONTAL POSITION

control so that the wave form crosses the major horizontal grid line at the left edge of the graticule.

4. Be sure that the center knob of the TIME BASE - FREQUENCY switch is fully clockwise, and adjust R286 so that one cycle of the 60Hz wave is 8.3cm long.

5X EXPAND and POSITION VERNIER

Set controls as follows:

HORIZONTAL SYNC	INT A
SYNC POLARITY	POSITIVE
HORIZONTAL SWEEP	AUTO TRIGGERED
TIME BASE - FREQUENCY	.5mSec/DIV
VERTICAL INPUT	A
CHANNEL A PPV PER DIV	.5V/DIV

1. Connect the output of the 2V PP calibrator to the input of CHANNEL A.

2. Adjust the center knob of the TIME BASE - FREQUENCY switch for 10 complete square waves in 10cm.

3. Pull the HORIZONTAL POSITION control to activate the 5X expand, and adjust R319 for two complete square waves in 10cm.

4. Turn the TIME BASE - FREQUENCY switch to the .1mSec/DIV position, and turn the center knob fully clockwise.

5. Adjust the HORIZONTAL POSITION control so that the negative going transition of the square wave lines up with the major vertical graph screen division.

6. Carefully push the HORIZONTAL POSITION control back in with out turning it, and adjust R321 and R322 to keep the negative transient lined up on the major vertical division.

7. Repeat steps 5 and 6 until the trace does not shift when the 5X expand is activated.

SYNC SEPARATOR BALANCE ADJUSTMENT

Set controls as follows:

HORIZONTAL SYNC	INT A
SYNC POLARITY	POSITIVE
HORIZONTAL SWEEP	AUTO TRIGGERED
TIME BASE - FREQUENCY	TV VERTICAL
VERTICAL INPUT	A
CHANNEL A PPV PER DIV	10V/DIV

1. Connect the CHANNEL A input to the Yellow/green wire on the terminal strip mounted on the rear apron of the chassis.

2. Set R215 to the center of the range that produces a stable pattern.

BLANKING LEVEL and OUTPUT STAGE COLLECTOR VOLTAGE ADJUSTMENT

Push the VECTOR VERTICAL INPUT BUTTON, set the CHANNEL A and CHANNEL B INPUT COUPLING switches to the center ground position, and set the INTENSITY control 15 degrees from the counter clock-wise position.

1. Adjust R604 on the high voltage supply board so the trace is just extinguished.

2. Adjust CHANNEL A TRACE POSITION control for equal voltage on the collectors (heat sinks) of TR 507 on the vertical output board, and adjust the CHANNEL B TRACE POSITION control for equal voltage on the collectors of TR506 and TR507 on the horizontal output board.

3. Adjust R520 on the vertical and horizontal output boards for exactly 115 volts on the collectors of TR 507 and TR508.

CAL. VOLTS 2V PP

First be sure that the preamplifiers are properly calibrated, then adjust R409 on the display board, so that the calibrate square wave fills four squares with the preamp VPP/DIV switch set to .5V/DIV.

CRT TILT ADJUSTMENT

Adjust the front panel controls to produce a clean horizontal trace, with no vertical deflection. Loosen the screw that secures the CRT to the shields at the rear of the shield. Use the lever provided on the CRT socket to adjust the tilt of the trace on the screen.

SERVICE PROCEDURES

The PS163 is a complex instrument, and repair should only be attempted by a technician qualified and experienced in the repair of miniature solid state electronic equipment. Note: if you do wish to service your PS163, special care must be taken when making measurements or connections to the +25, +15, and -25 volt power supplies. The ripple filter transistors TR 700 - TR702 are not short circuit protected, and even a momentary short to the output of one of these supplies will result in the destruction of the associated transistor.

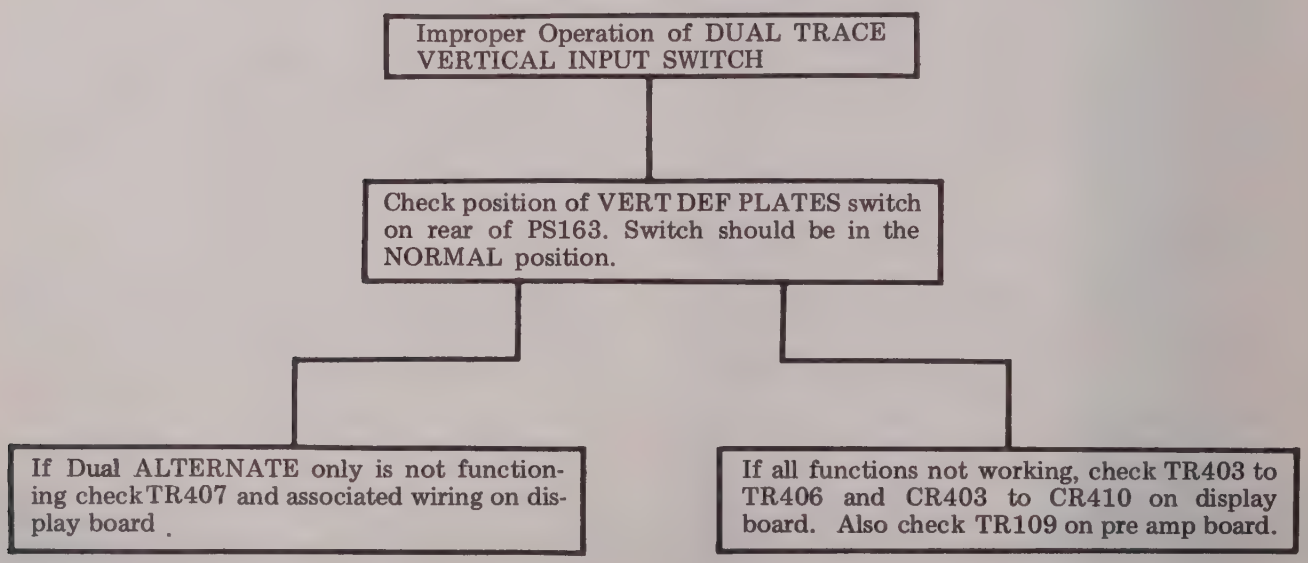
For those who wish to service their own PS163, we have included a series of trouble charts to help isolate the section in which the problem is located. Also included are both the component view and foil side view of the printed circuit boards. The foil side view of the board shows the location of all transistors, adjustments and test points. The charts that accompany the views of each board show the incircuit gain and leakage readings for all transistors as measured with a Sencore TF151A, as well as the incircuit resistance readings from each transistor pin to ground as measured with a Sencore FE160, Field Effect Multimeter, using low power ohms. All of the above measurements were taken under the following conditions.

HORIZONTAL SYNC	INT A
SYNC POLARITY	POSITIVE
HORIZONTAL SWEEP	AUTO TRIGGERED
TIME BASE - FREQUENCY	100mSec/DIV
PPV PER DIV	.05V/DIV
INPUT COUPLING	DC COUPLED

To aid in locating a particular component, the PS163 schematic reference numbers have been coded to indicate which section of the PS163 the component is located in. The coding is as follows:

1 - 99	Chassis
100 - 199	Pre-amplifier
200 - 399	Time base and trigger circuit
400 - 499	Display board and 2V calibrator
500 - 599	Output amplifier
600 - 699	H. V. Power supply
700 - 799	L. V. Power supply

TROUBLE CHARTS


Improper Operation of DUAL TRACE VERTICAL INPUT SWITCH
Check position of VERT DEF PLATES switch on rear of PS163. Switch should be in the NORMAL position.
If Dual ALTERNATE only is not functioning check TR407 and associated wiring on display board .
If all functions not working, check TR403 to TR406 and CR403 to CR410 on display board. Also check TR109 on pre amp board.

NO VERTICAL DEFLECTION ONE CHANNEL ONLY (Horizontal Sweep Normal)

Connect the CAL VOLTS 2VPP to the input of both channels, and press the DUAL ALTERNATE VERTICAL INPUT button. Press the HORIZONTAL SYNC BUTTON corresponding to the defective channel, and the MANUAL TRIGGERED HORIZONTAL SWEEP button. Adjust the SYNC LEVEL control to obtain a trace.

- If a trace is obtained, the problem is located in the display board or associated wiring.
- If a trace is not obtained, the trouble is located in the preamp. Use the working channel to troubleshoot the defective channel.

UNSTABLE SYNC

Check All Positions of the HORIZONTAL SYNC SWITCH

- If unstable in one position only check wiring, and TR109 on preamp board.
- If unstable in all positions check adjustment of STABILITY and BALANCE controls on time base board.
  - If balance control does not have proper effect check circuit of TR205 - TR212 on time base board.
  - If stability control does not have proper effect, check circuits of TR215 to TR219 on time base board.
  - If neither control has proper effect, check ripple filter transistors TR700-702 on L.V. supply.

NO HORIZONTAL SWEEP
(Normal Vertical Deflection)

Turn the TIME BASE - FREQUENCY switch to the 60 cycle position

If sweep appears, trouble is located on the time base board in the circuits of TR218 - TR230.

If no sweep, press the VECTOR VERTICAL INPUT button and apply the 2VPP CAL VOLTS to the CHANNEL B input.

If sweep appears trouble is on the time base board in the circuits of TR232-TR236

If no sweep, trouble is in the Horizontal output amplifier or associated wiring.

NO TRACE

Check circuit breaker on rear of unit.

Turn INTENSITY fully clockwise. Depress VECTOR VERTICAL INPUT button. Set TRACE POSITION controls to mid rotation.

If a dot appears on screen, check time base circuits of TR218 to TR226.

If no dot appears on screen, check output of both high and low voltage power supply.

If power supplies OK, check voltages at CRT and the CRT itself.

If either power supply does not have proper output, troubleshoot defective supply. Be sure to check in circuit resistances listed for that section.

NO VERTICAL DEFLECTION
BOTH CHANNELS
(Horizontal Sweep Normal)

Press the VECTOR VERTICAL INPUT button and connect the CAL VOLTS 2VPP to the input of CHANNEL B.

If horizontal deflection is obtained then the problem is in the Vertical output board or associated wiring.

If no horizontal deflection, connect the CAL VOLTS 2V PP to the input of both channels, and press the DUAL ALTERNATE VERTICAL INPUT button. Press the MANUAL TRIGGERED HORIZONTAL SWEEP button. Depress the CHANNEL B HORIZONTAL SYNC button and adjust the SYNC LEVEL control to obtain trace. Repeat with CHANNEL A HORIZONTAL SYNC button depressed.

If proper sync is obtained the problem is in the display board or associated wiring.

If sync is not obtained on either channel, a defect is present in both preamplifiers.

BOARD LAYOUTS AND TABLES

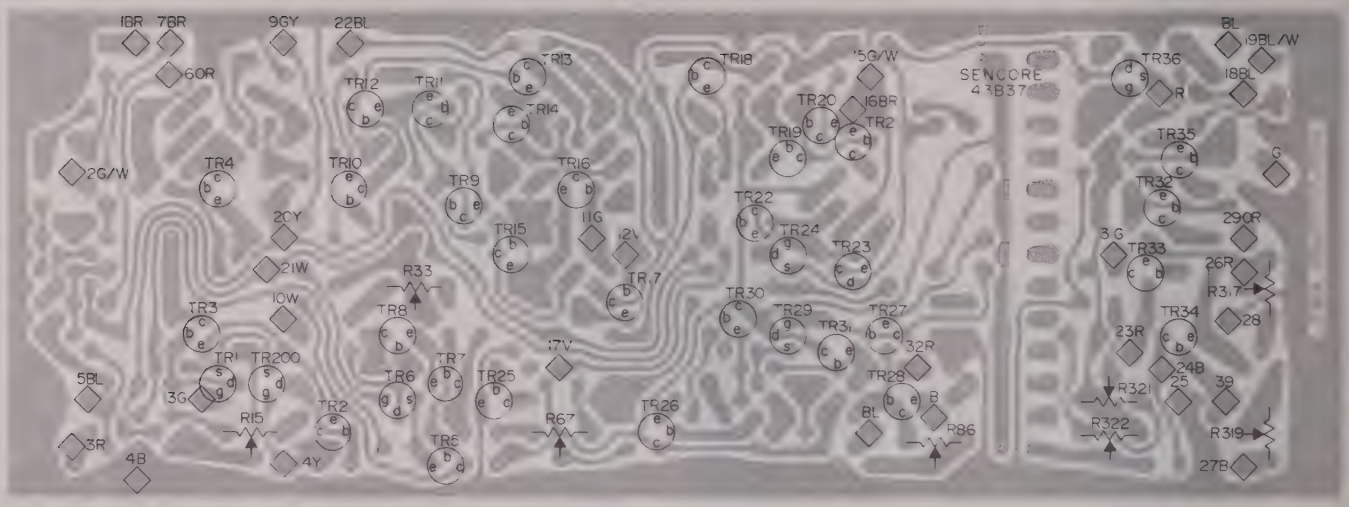


Fig. 1-A. Foil side view with board legend.

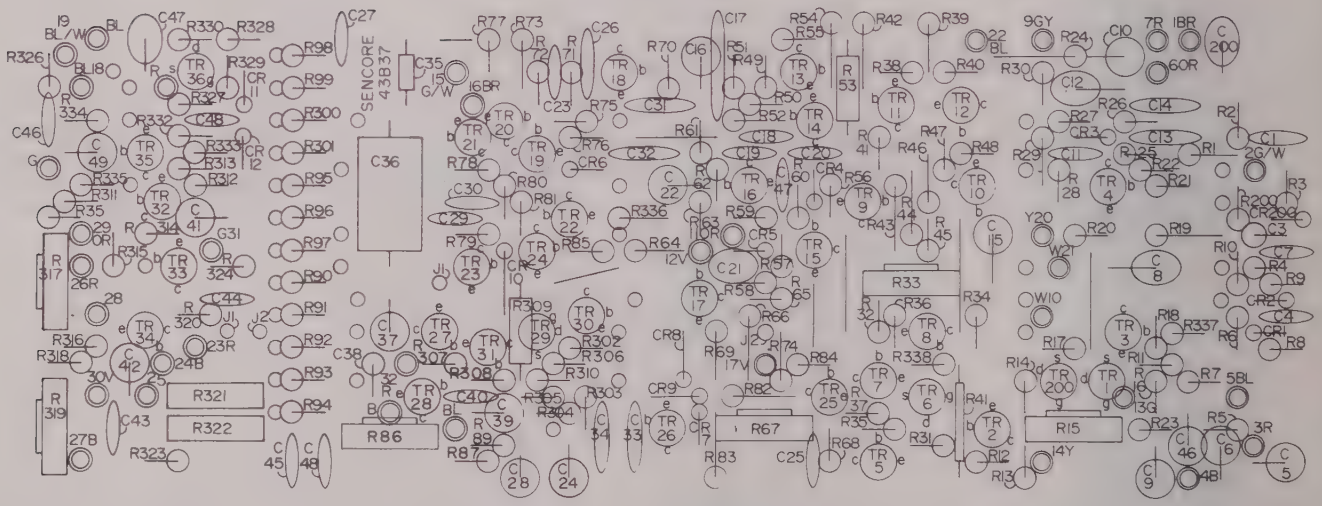


Fig. 1-B. Component side view.

TIME BASE BOARD

TR NUMBER	TYPE NUMBER	POL.	BETA/ GM*	LEAKAGE Icbo Igss* In uA	RESISTANCE TO GROUND (.08V max) † E/S	B/G	C/D
200	U1837	NCH	4500	1,000	2.8K	0	2.8K
201	U1837	NCH	4500	1,000	2.8K	0	2.8K
202	2N5227	PNP	35	500	3.9K	2.8K	3.1K
203	2N5227	PNP	27	500	3.9K	2.8K	3.1K
204	2N5227	PNP	70	70	750	50K	3.3K
205	U1837	NCH	4500	1,000	2.5K	0 (1)	2.5K
206	U1837	NCH	4500	1,000	2.5K	1.4M (1)	2.5K
207	2N5227	PNP	25	600	3.9K	2.5K	2.9K
208	2N5227	PNP	35	600	3.9K	2.5K	2.9K
209	2N5172	NPN	150	400	9.5K	2.9K	4.8K
210	2N5172	NPN	125	400	9.5K	2.9K	4.8K
211	2N5227	PNP	200	600	3.9K	4.8K	3K
212	2N5227	PNP	190	600	3.9K	4.8K	3K
213	TP4174	NPN	60	500	470	3K	1.4K
214	TP4274	NPN	65	750	470	3.6K	1.6K
215	2N5172	NPN	150	65	0	44K	1.4K
216	2N5172	NPN	00	500	0	55K	5.7K
217	2N5172	NPN	125	200	270	15K	1.4K
218	TP4247	NPN	35	80	3.6K	33K	2.7K
219	TP4247	NPN	75	750	8	2.7K	2.2K
220	2N5172	NPN	inf.	2,000	inf.	2.2K	1.4K
221	2N4248	PNP	inf.	1,500	inf.	2.2K	1.1K
222	2N5172	NPN	150	200	1K	12K	6.8K
223	2N4248	PNP	125	200	0	inf.	6.8K
224	2N4248	PNP	125	80	0	41K	6.8K
225	2N4248	PNP	100	20	0	110K	100K
226	2N4248	PNP	50	2,000	60	22K	1K
227	2N5172	NPN	150	0	700K (2)	15K	inf.
228	2N5172	NPN	200	75	4.4K	15K	15K
229	2N5461	PCH	2500	0	1.5K	inf.	1K
230	2N4248	PNP	100	3,000	24K	1.5K	1K
231	2N4248	PNP	125	5,000	27K	24K	1K
232	2N4248	PNP	400	0	1.1K	2.8K	inf.
233	2N5227	PNP	125	80	inf.	12K	39K
234	2N5227	PNP	125	80	inf.	8.5K	30K
235	2N4248	PNP	125	95	2.4K	39K	2.2K
236	MPF103	NCH	test out of circuit		1.7K	1M	1.4K

(1) will change with Sync Polarity
(2) varies with Time/Div. switch

* BETA & LEAKAGE measurements taken with SENCORE TF17 or TF151.
† RESISTANCE measurements taken with SENCORE Hi-LO Multimeter.

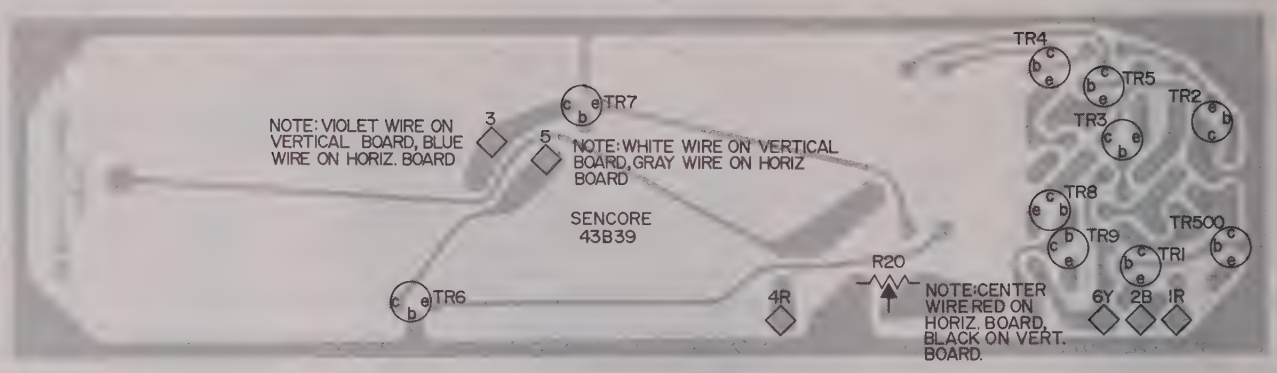


Fig. 2-A. Foil side view with board legend.

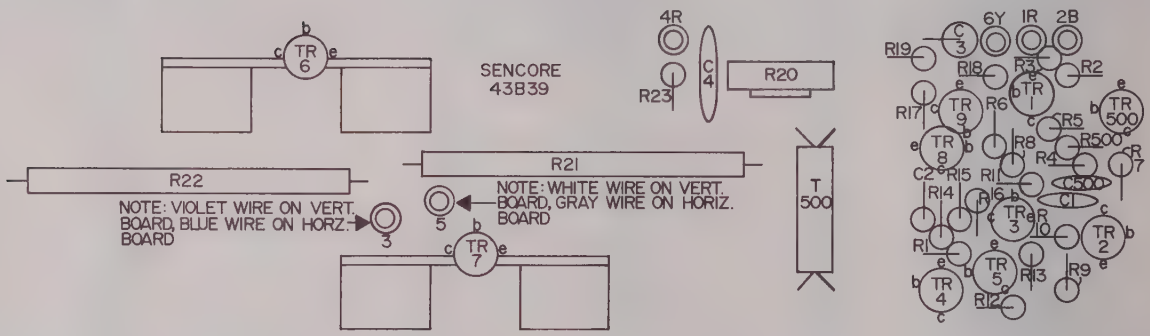


Fig. 2-B. Component side view.

OUTPUT BOARD

TR NUMBER	TYPE NUMBER	POL.	BETA/ GM*	LEAKAGE Icbo Igss* In uA	RESISTANCE TO GROUND (.08V)† E/S	B/G	C/D
500	2N5227	PNP	90	2,000	39K	0	2.2K
501	2N5227	PNP	175	2,000	39K	0	2.2K
502	SE3002	NPN	90	2,000	2.2K	2.3K	0
503	SE3002	NPN	80	2,000	2.2K	2.3K	0
504	D40D1	NPN	65	0	inf.	2.3K	inf.
505	D40D1	NPN	38	0	inf.	2.3K	inf.
506	D40N1	NPN	10	40	inf.	0	cap
507	D40N1	NPN	10	40	inf.	0	cap
508	2N5172	NPN	50	0	1K	8K	inf.
509	2N5172	NPN	1000	5,000+	2.2K	8K	8K

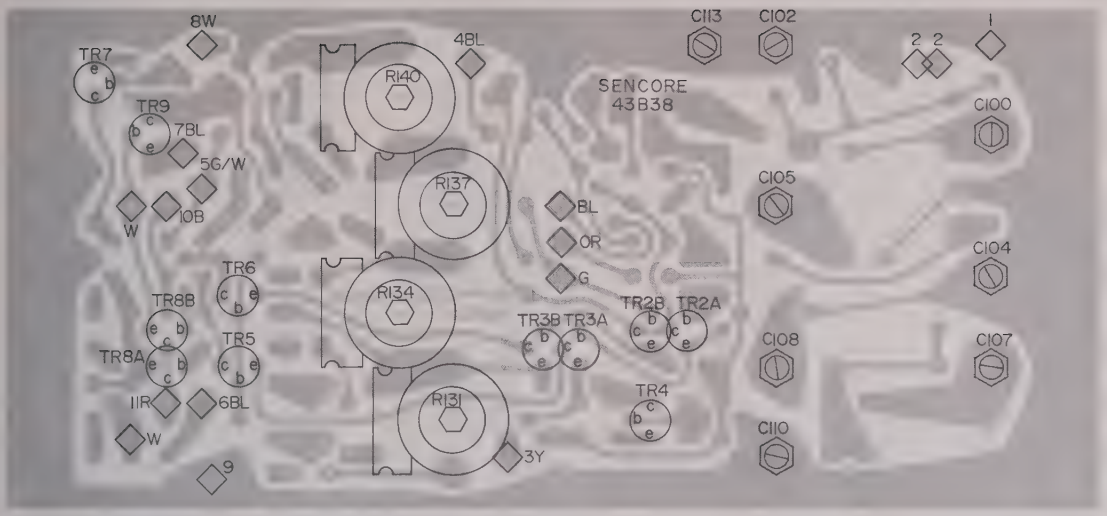


Fig. 3-A. Foil side view with board legend.

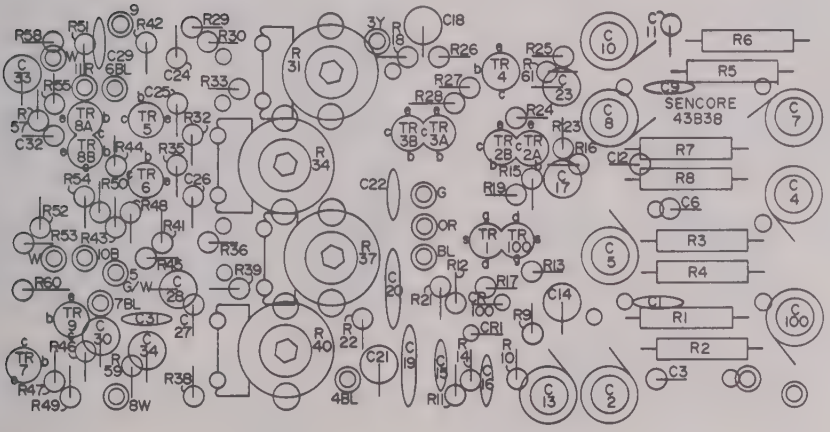


Fig. 3-B. Component side view.

PRE AMPLIFIER BOARD

TR NUMBER	TYPE NUMBER	POL.	BETA/ GM*	LEAKAGE Icbo Igss* In uA	RESISTANCE TO GROUND (.08V max)† E/S	B/G	C/D
100	MPF102	NCH	3800	1,000	1.7K	1.4M	1.2K
101	MPF102	NCH	4500	5	1.7K	1M	1.2K
102A	TD101	NPN	250	5,000	13K	2K	1.2K
102B	TD101	NPN	250	5,000	13K	2K	1.2K
103A	TD101	NPN	250	0	inf.	13K	inf.
103B	TD101	NPN	250	0	inf.	13K	inf.
104	SE3002	NPN	90	0	1.3K	4.7K	inf.
105	SE3002	NPN	50	1,000	inf.	1.2K	2.5K
106	SE3002	NPN	50	1,000	inf.	1.2K	2.5K
107	2N4248	PNP	150	0	1.3K	2.8K	inf.
108A	TD401	PNP	60	500	inf.	2.6K	6K(1)
108B	TD401	PNP	60	500	inf.	2.6K	6K(1)
109	SE3002	NPN	90	0	10K	inf.	900

(1) Varies with trace position control

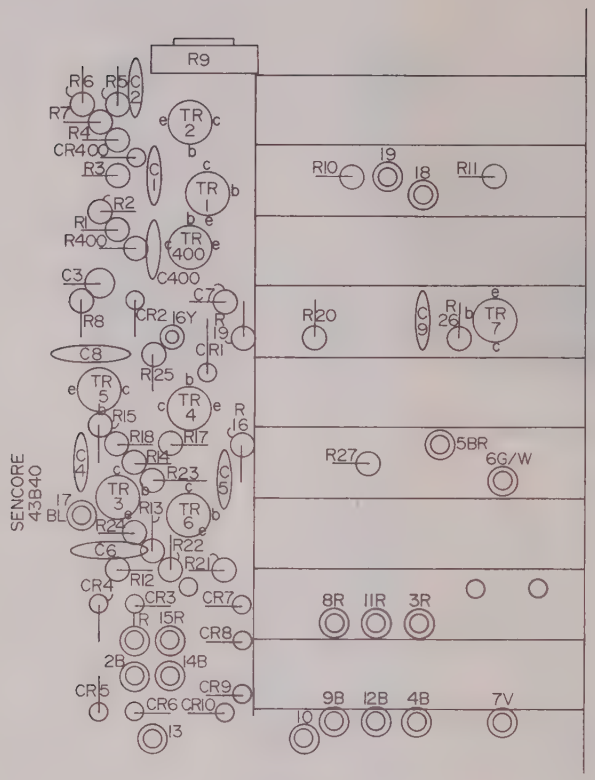


Fig. 4-A. Foil side view with board legend.

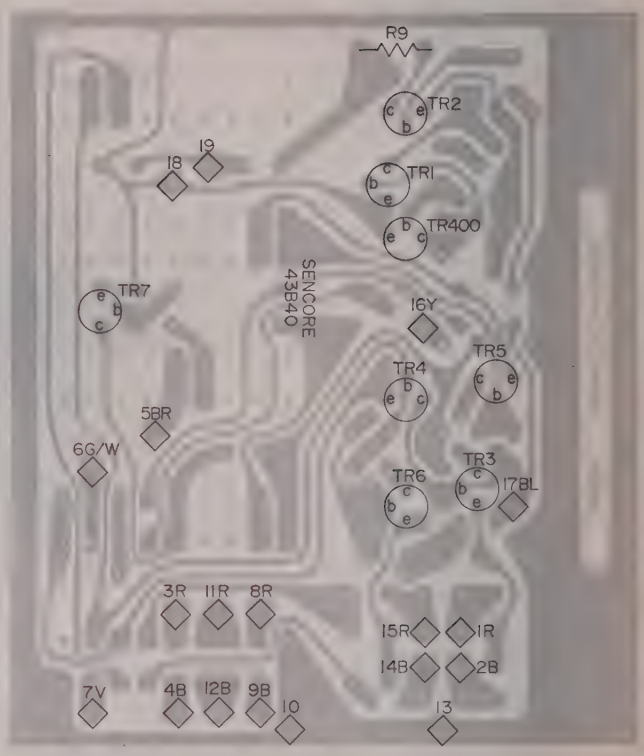


Fig. 4-B. Component side view.

DISPLAY BOARD

TR NUMBER	TYPE NUMBER	POL.	BETA/ GM*	LEAKAGE Icbo Igss* In uA	RESISTANCE TO GROUND (.08V)† E/S	B/G	C/D
400	SE3002	NPN	16	125	0	30K	3.5K
401	SE3002	NPN	17	125	0	30K	3.5K
402	2N4248	PNP	150	175	2K	6K	12K
403	2N4248	PNP	125	500	12K	4.4K	1.8K
404	SE3002	NPN	65	125	7.5	30K	4.4K
405	SE3002	NPN	55	125	7.5	30K	4.4K
406	2N4248	PNP	200	500	12K	4.4K	1.8K
407	2N4248	PNP	65	200	0	10K	3.9K

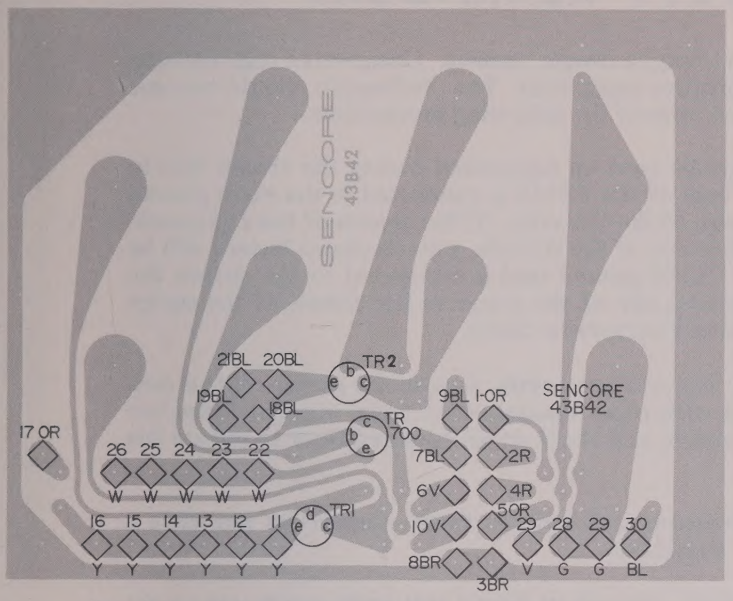


Fig. 5-A. Foil side view with board legend.

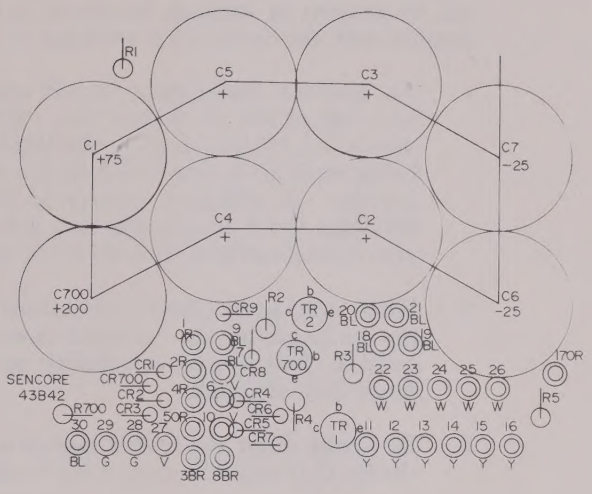


Fig. 5-B. Component side view.

L V SUPPLY BOARD

TR NUMBER	TYPE NUMBER	POL.	BETA/ GM*	LEAKAGE Icbo Igss* In uA	RESISTANCE TO GROUND (.08V max) † E/S	B/G	C/D
700	D40D1	NPN	200	5,000	750	cap	cap
701	D41D1	PNP	250	5,000	1K	cap	cap
702	D40D1	NPN	150	5,000	1.3K	cap	cap

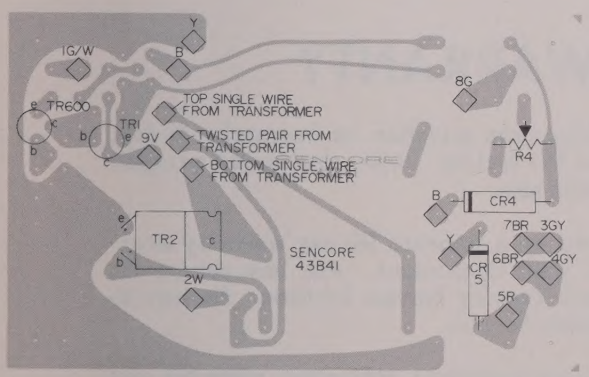


Fig. 6-A. Foil side view with board legend.

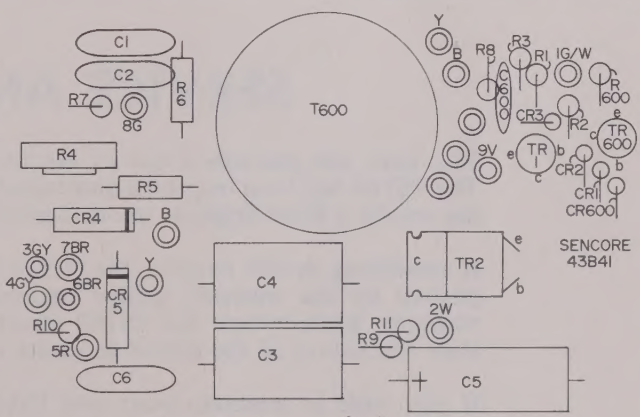


Fig. 6-B. Component side view.

H V SUPPLY BOARD

TR NUMBER	TYPE NUMBER	POL.	BETA/ GM*	LEAKAGE Icbo Igss* In uA	RESISTANCE TO GROUND (.08V max)† E/S	B/G	C/D
600	2N3877A	NPN	200	110	inf.	6.3M	43K
601	2N3877A	NPN	inf.	500	100K	43K	35K
602	T1P29A	NPN	27	1,000	0	3.9K	750

SENCORE SAFETY REMINDERS

When testing electronic equipment, there is always a danger present. Unexpected high voltages can be present at unusual locations in defective equipment. The technician should become familiar with the device he is working on and observe the following precautions.

1. An isolation transformer should always be used on equipment having the chassis tied to one side of the AC power line. The case of the PS163 is connected to the earth ground side of the AC line through the third wire of the line cord. If the chassis of the equipment being serviced is connected to the other side of the AC line, a severe shock hazard will be present. In addition, as soon as the PS163 ground lead is connected to the chassis the resultant short circuit will fuse the ground clip of the scope to the chassis of the equipment being serviced, and blow the fuse to your service bench.

2. When making test lead connections to high voltage points, remove the power. If this cannot be done, be sure to avoid contact with other equipment or metal objects. Place one hand in your pocket as a safety precaution and stand on an insulated floor to reduce the possibility of shock.

3. Discharge filter capacitors before connecting test leads to them. Capacitors can store a charge that could be dangerous to the technician.

4. Be sure your equipment is in good order. Broken or frayed test leads can be extremely dangerous and can expose the technician to dangerous potentials.

5. Remove the test leads immediately after the test has been completed to reduce the possibility of shock.

6. Do not work alone when working on hazardous circuits. Always have another person close by in case of accident. Remember, even a minor shock can be the cause of a more serious accident, such as falling against the equipment, or coming in contact with higher voltages.

SERVICE AND WARRANTY

You have just purchased one of the finest oscilloscopes available on the market today. The PS163 has been inspected and tested twice at the factory. It has also passed a rugged use test by a Field Engineer in our Zero Defects test area.

If something should happen, the PS163 is covered by a standard 90 day warranty as explained by the warranty policy enclosed with your instrument. For best service on warranty work, return the PS163 directly to our Factory Service Division. Be sure to state the nature of the defect to assure rapid return to you.

If you wish to maintain your own PS163, we have enclosed a schematic, parts list and trouble chart. Any parts needed may be ordered directly from the Factory Service Division.

We reserve the right to examine defective components before an in-warranty replacement part is issued.

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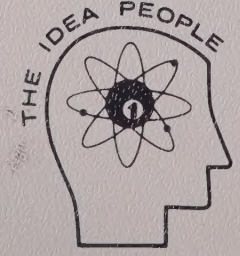

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